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ABSTRACT

The aim of management information systems is to satisfy the information need managers have to successfully accomplish their tasks. The quality of management decisions is highly dependent on the information they are based on. A structured conception of these systems is a crucial task that has to precede their implementation and monitoring. Several conceptual modeling methods (CMM) for business intelligence applications have been developed in order to support the specification of data warehouse structures and management information systems. However, none of them was found to be appropriate to bridge the communication gap in the process of requirements analysis. Thus, in an ongoing research effort, a CMM has been designed to adequately support the system conception. Several case studies were conducted and in an iterative process the findings were incorporated to improve the initial CMM. The result of this process is a CMM quite different to the original one. The aim of this paper is to elaborate on the evolutionary development of a CMM and to show how it has successfully been applied in multiple case studies.

Keywords

Management Information Systems, Method Engineering, Evolutionary Design, Conceptual Modeling, Design Science Research, Case Study.

INTRODUCTION

The aim of management information systems is to satisfy the information need managers have to successfully accomplish their tasks. The quality of management decisions is highly dependent on the information they are based on. Thus, a structured conception of management information systems including a comprehensive information requirements analysis is a crucial task that has to precede their implementation and monitoring (Jiang, Klein and Discenza 2001). Information requirements analysis has to support the conceptual specification of information needs (Winter and Strauch 2004). To facilitate information requirements analysis there is demand for a conceptual modeling method (CMM) that is understandable to both IT developers and system users. By this, management support and user participation in the development process can be increased dramatically (Becker, Dreiling and Ribbert 2003, Wixom and Watson 2001). Furthermore, the CMM should hold a degree of formality that allows for the derivation of data warehouse and OLAP structures and thus fosters the implementation of the subsequent system (Holten 2002).

The aim of this paper is to present an ongoing research effort in which a CMM for adequately supporting the conception of a management information system has been designed. The work we describe here spans across a period of altogether nine years. During this time five case studies and multiple iterations through the research process were performed. Due to word limitations, in this paper we present only two cases. However, the selected cases document all significant changes in the CMM. We show how the CMM has been applied to successfully conceptualize management information systems. In an iterative process the findings of the case studies were incorporated to improve the initial CMM.

The paper is based on the following hypotheses: Method engineering is a continuous, evolutionary process which does not converge to a universal method which meets all technical and organizational contingencies. Secondly, an application of the CMM improves the company wide communication and supports the identification as well as the elimination of weaknesses in the current management information systems. Thirdly, an application of the CMM is useful for the technical implementation of a management information system.

The structure of the paper is as follows: First, we elaborate on the foundation of our research endeavor by stating philosophical assumptions and explain the research methodology that guided us through the evolutionary process of method engineering. Second, we provide an overview of related work and provide a starting point for the design of the original CMM. Third, we present two case studies followed by a cross case analysis to describe the changes that were made in the process. We conclude summarizing our results and provide an outlook to future research activities.

RESEARCH METHODOLOGY

The research methodology of this paper is illustrated in Figure 1. This research belongs to the design science paradigm (Hevner, March, Park and Ram 2004, March and Smith 1995). It strives for developing a practically relevant IT artifact in form of a domain independent, purpose specific CMM. The research methodology is based on the work of Takeda et al. (Takeda, Veerkamp, Tomiyama and Yoshikawa 1990), Rossi et al. (Rossi, Ramesh, Lyytinen and Tolvanen 2004), Greiffenberg (Greiffenberg 2004), Eisenhardt (Eisenhardt 1989), Walsham (Walsham 1995) and Kamlah & Lorenzen (Kamlah and Lorenzen 1984).

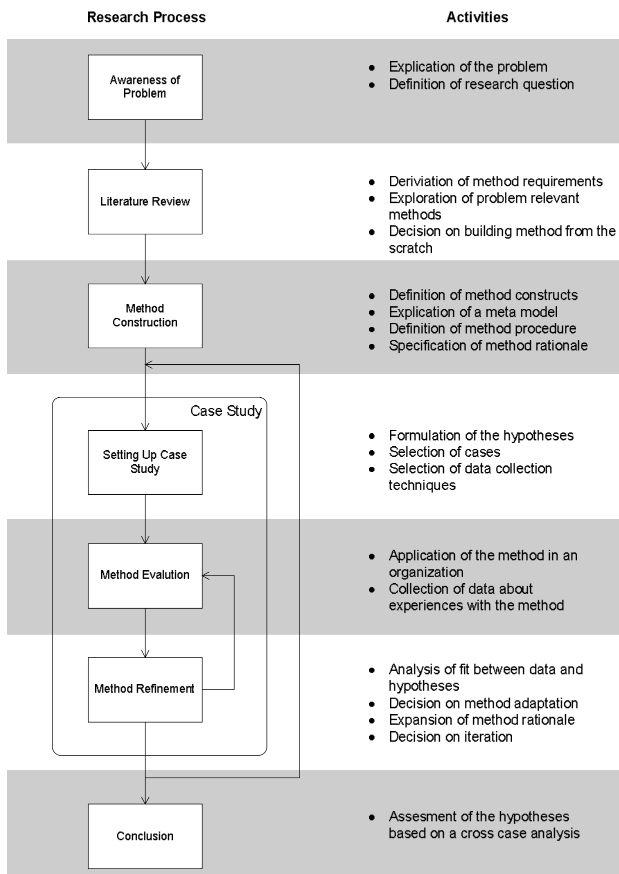

Figure 1. Research Methodology of this Paper.

The research process started with the awareness of a practical problem (Takeda et al. 1990). The practical problem the researchers were concerned with and still are can be formulated by the following research question: How to specify a management information system on a conceptual level? The aim of the research process is to provide a CMM guiding the development of a management information system. Our comprehension of an architecture of a CMM is described in Figure 2.

The practical need for such a CMM became apparent in discussions with IT managers about their experiences with management information systems (inductive reasoning) at the one hand and from theoretical considerations about cost accounting theory (deductive reasoning) at the other hand (Holten 1999). From the inquiry it turned out that to solve the identified practical problem such a CMM must:

(R1) *Foster the company wide communication in order to identify relevant information needs and eliminate weaknesses in the current management information systems.* The effective implementation of a management information system must be preceded by an in-depth information requirements analysis including an evaluation of the current management information system. This necessitates a sound communication between IT developers and system users. Hence, a CMM must support this process by providing a conceptual language that can be understood by both parties.

(R2) *Prepare and assist the technical implementation of the management information system.* From a technical perspective a management information system consists of a data warehouse, a corresponding online analytical processing (OLAP) tool as well as standard reporting tools. As the Entity Relationship approach (Chen 1976) prepares the implementation of a database structure, the CMM should provide the conceptual basis for an implementation of a data warehouse structure. Furthermore, the models of the CMM should serve as a template for the specification of the reports in OLAP and standard reporting tools.

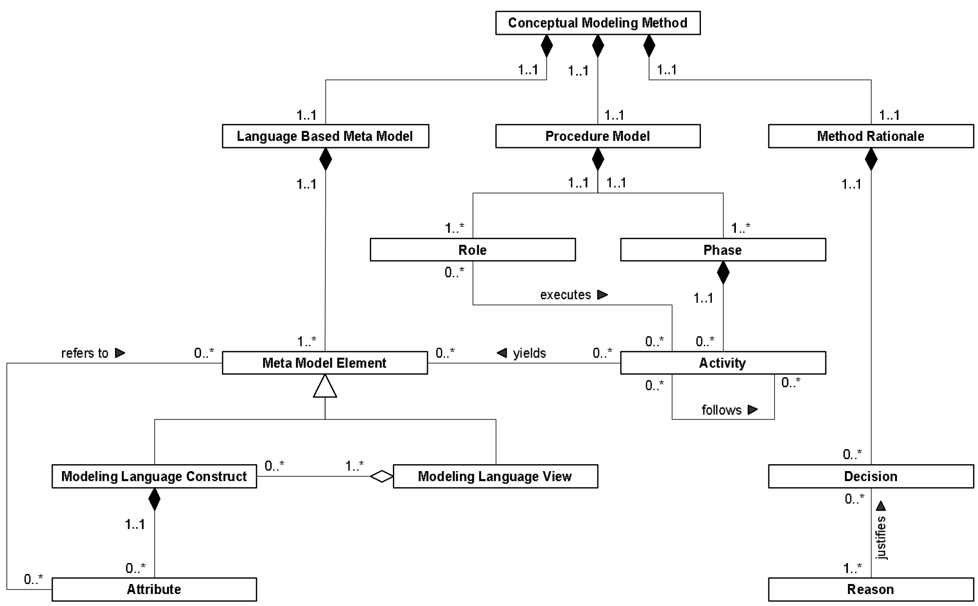

Figure 2. Architecture of a conceptual modeling method.

In the next step of the research process, a literature review has been performed in order to consider previous work on management information systems (cf. section 3 on related work). Based on (R1) and (R2) the study of literature resulted in a set of requirements which must be met by a CMM in order to be able to specify a management information system. Three major approaches could be identified which already aimed at the specification of management information systems. However, a detailed analysis of these approaches based on the comparison process of Song & Osterweil (Song and Osterweil 1994) showed that they do not fulfill all relevant requirements. Therefore, the decision was made to develop a CMM for the specification of management information systems from scratch.

The construction process of the CMM (Holten 1999, Holten 2001) is similar to the procedures proposed by Greiffenberg (Greiffenberg 2004, p. 166 ff.) and Gupta & Prakash (Gupta and Prakash 2001, p. 143). First, all relevant *Modeling Language Concepts* were identified by deducing them from Riebels cost accounting theory (Riebel 1979) and reconstructing them based on Kamlah and Lorenzen's language critique approach (Kamlah and Lorenzen 1984). Afterwards, the resulting concepts were supplemented with *Attributes* and, thus, relations between the concepts were established (Gupta and Prakash 2001, p. 143). In the next step, the *Modeling Language Constructs* have been assigned to one or more *Modeling Language Views* in order to reduce the complexity of the resulting conceptual models. All elements of the conceptual modeling language as part of the CMM have then been consolidated in form of a *Language Based Meta Model*. Subsequently, the

Activities as well as the *Roles* executing the *Activities* were defined. Now, the sequence of the *Activities* has been specified and the *Activities* were combined to *Phases*. To make all those design choices traceable all *Decisions* including their *Reasons* have been documented in form of a *Method Rationale* (Rossi, Tolvanen, Ramesh, Lyytinen and Kaipala 2000, p. 6 ff.).

The evaluation of the CMM has been performed in multiple case studies (Yin 2003, p. 46 ff.). While setting up these case studies the following three hypotheses were generated based on (R1) and (R2) as well as on considerations from evolutionary method engineering:

(H1) An application of the CMM improves the company wide communication and supports the identification as well as the elimination of weaknesses in the current management information system.

(H2) An application of the CMM is useful for the technical implementation of a management information system.

(H3) Method engineering is a continuous, evolutionary process which does not converge to a universal method which meets all technical and organizational contingencies (Rossi et al. 2004, p. 358).

Using theoretical sampling (Eisenhardt 1989, p. 537, Glaser and Strauss 1967, p. 45 ff.) in each of the two iterations an organization was identified, which faced the problem of inaccuracies and inconsistencies in its management information system. Since the problem of these organizations and the scope of the CMM corresponded, these companies were selected for an application of the CMM. As data collection techniques, interviews and document analyses have been used. The names of the companies, facts on performed interviews, and the examined documents are listed in Table 2. The interview partners in the organizations were chosen according to the corresponding roles of the procedure model of the CMM. As relevant roles persons in charge of the reporting, report recipients, and system administrators were identified. Moreover, relevant documents were selected according to the procedure model of the CMM. Strategy documents, reports, specifications of the IT infrastructure, documents on the organizational structure, and process models have been considered.

Organization	**Number of Interviews**	**Interview Partners**	**Examined Documents**
Swiss Re	7	Financial Service Manager, Risk Manager, IT Project Manager	Paper based reports, contracts
Christ Juweliere und Uhrmacher seit 1863 GmbH	21	CIO, Controlling, Top Management, Managers Purchasing, Managers Sales, Managers Logistics, IT Department	Standard reports (daily, monthly), purchasing data warehouse

Table 2. Facts on the two case studies.

In order to evaluate the CMM it has been applied in organizations. As a data collection technique interviews were used. Guided by the procedure model of the CMM in a series of semi-structured open-ended questions the participants were asked to explicate their information needs and to specify the data they can provide to satisfy the information requirements of the company. The interviewer documented the responses of the interview partners by applying the modeling language of the CMM. As a second data collection technique the documents of the organizations were analyzed according to the information needs and the available information stock. The resulting data was described by using the same modeling language of the CMM. During the application of the CMM the interviewer noted the reactions of the interview partners on the procedure of the CMM. The interviewer (method expert) also recorded statements from interview partners as well as described facts extracted from documents, which were relevant from his perspective for the specification of the management information system, but not describable by means of the CMM.

The experiences from the interviews and the document analyses were then compared to the hypotheses. New requirements on the CMM were derived, deficiencies in the CMM were identified, and suggestions for improvement were specified. Depending on the number and the importance of the proposed changes, the CMM has then been adapted. *Modeling Language Constructs* were introduced, were omitted or were modified. All *Decisions* about adaptations of the CMM including their *Reasons* were documented in form of a *Method Rationale*. After the adaptation of the CMM the interviews and the document analysis continued with the new version of the CMM. This cycle of interviews, document analyses, and method adaptations has been continued until the management information system of the organization has been specified completely. Then it has been decided whether a new case study should be started.

After two iterations the findings of the case studies were evaluated in a cross case analysis.

RELATED WORK ON MANAGEMENT INFORMATION SYSTEMS

In order to exchange thoughts, opinions and beliefs about the development process of management information systems and its objectives, representation forms of the object system have to be created. Conceptual modeling is considered to be a suitable tool for creating such representation forms respectively conceptual models (Frank 1999). As mentioned above, three modeling approaches were identified that are of major importance to the design of management information systems: the Multidimensional Entity Relationship Model (ME/RM) (Sapia, Blaschka, Höfling and Dinter 1998), the Application Design for Analytical Processing Technologies (ADAPT) (Bulos 1996, Bulos 1998), and the Dimensional Fact Model (DFM) (Golfarelli, Maio and Rizzi 1998). Generic approaches to system design, such as UML/OO, Structured Analysis and Design Technique (SADT) or System Dynamics, were not taken into account. They do not contain explicit model constructs for the design of management information systems (see below). This, however, is the goal of this CMM.

ME/RM: Since the Entity Relationship (ER) Model of Chen (Chen 1976) does not provide sufficient support in the design of multidimensional structures the *Multidimensional Entity Relationship Model* is proposed. The aim is to only slightly enhance the ER language to ensure the flexibility and the simplicity of the ER notation but to allow the definition of hierarchies with qualifying and quantifying data and the hierarchical structure of the qualifying data. New constructs are a fact relationship set, a dimension level set, and a roll-up relationship set. The former connects atomic dimension levels (i. e. the dimension hierarchy) while the latter connects different dimension levels. Attributes that are assigned to the fact relationship set are regarded to as ratios. An obvious drawback of ME/RM is that alternative hierarchies are complicated to model.

ADAPT: The *Application Design for Analytical Processing Technologies* approach is independent of any prior existing modeling language. The core elements of the language are hypercubes and dimensions. Each cube can have multiple dimensions. Each dimension consists of one or more hierarchies which in turn consist of levels. Each dimension can be associated with members, scopes, and attributes. Members are singular objects of the dimension, scopes are collections of members, and attributes are descriptive information about members of a dimension. Furthermore, models and contexts can be added. Models in this case are algebraic calculation of derived data and a context is a section of a hypercube. Ratios are associated with a cube via a ratio dimension. ADAPT covers most of the required modeling language constructs specified below. However, a comparable construct to dimension scope combinations is not available and certain constructs, such as member, turn to be complex in extensive models. ADAPT was not developed for modeling on instance level (i. e. “Audi, BMW” instead of “Car”).

DFM: The *Dimensional Fact Model* provides so-called dimensional schemes which consist of a set of fact schemes whose basic elements are facts, dimensions, and hierarchies. The DFM, too, was developed to fill the conceptual gap between the end-user's requirements and the logical or physical design of the data warehouse. The center of any DFM is the fact. It is usually provided with fact attributes, i. e. ratios that measure the fact. Hierarchies are ordered around the fact and provide aggregation paths of dimensions and their attributes that are situated along the path. Dimensions are the finest level of information. Apart from dimension attributes there may be non-dimensional attributes which cannot be used for aggregation. A drawback hindering the use of DF models to foster communication with non-IT staff is that DFM abstracts from the actual object instances and only shows hierarchy levels.

Modeling Language Construct	**ME/RM**	**ADAPT**	**DFM**
Dimension Object	-	Member	-
Dimension	-	Hierarchy	-
Hierarchy Level	Dimension Level Set	Level	Dimension, Dimension Attribute
Dimension Scope	-	Scope	-
Dimension Grouping	-	Dimension	Hierarchy
Dimension Scope Combination	-	-	-
Ratio	Attribute	Member	Fact Attribute (Measure)
Ratio System	-	Measure Dimension	-
Information Object	Fact Relationship Set	Hypercube/ Cube	Fact

Table 3. Comparison of Modeling Constructs.

In a comprehensive analysis, required modeling language constructs for the specification of management information systems were defined (Holten 1999, Holten 2001). Table 3 shows the required modeling language constructs and how they are supported by existing CMMs (cf. equally Knackstedt 2004). The table lists semantically similar constructs. If a modeling language construct is not available in a CMM this is denoted by "-". This analysis led to the conclusion to develop a CMM from scratch that contains all necessary constructs and fosters modeling on instance level.

Since 1999 when the final decision was made to design the new CMM, other approaches have been proposed to model data warehouse structures. Apart from the Common Warehouse Metamodel (Open Management Group 2001) several efforts to create other modeling methods for data warehousing semantics include but are not limited to the extension of the UML as proposed by Totok (Totok 2000) as well as another ER based approach, starER (Tryfona, Busborg and Christiansen 1999), and the Multidimensional Aggregation Cube (MAC) (Tsois, Karayannidis and Sellis 2001). For other comparison efforts besides this cf. (Abello, Samos and Saltor 2000, Gabriel and Gluchowski 1998, Hettler, Preuss and Niedereichholz 2003, Tsois, Karayannidis and Sellis 2001).

METHOD CONSTRUCTION AND EVALUATION

METHOD CONSTRUCTION: METAMIS

As mentioned above, the MetaMIS approach has been developed to conceptually specify information needs. It comprises a conceptual language that facilitates the communication between management and IT analysts. Besides, MetaMIS models can be used to derive data structures for the development of data warehouses and management information systems (Holten 2002). The conceptual language is used within a procedure model that comprises both as-is-analysis and to-be-conception (Holten 1999). For a more comprehensive introduction of MetaMIS than we can give here cf. Holten (Holten 2002).

Basic constructs of MetaMIS are dimensions and ratios. Dimensions serve to organize information spaces. Dimensions consist of dimension objects such as certain products that can be ordered hierarchically by different aggregation levels such as product groups. This concept is based on the enterprise theory by Riebel (Riebel 1979). To specify the information need respectively a report for certain management tasks it is necessary to specify extracts from dimensions. These extracts are called dimension scopes and are sub trees of a dimension. Figure 3 depicts an exemplary dimension and a dimension scope derived from that dimension.

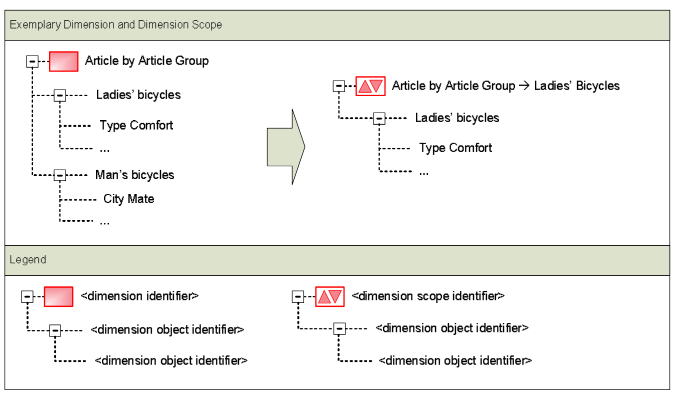

Figure 3. Exemplary Dimension and Dimension Scope.

Dimension scopes always refer to exactly one dimension. However, management views are multidimensional in most cases. Thus, dimension scopes can be combined to dimension scope combinations. Dimension scope combinations represent multidimensional sub spaces of the overall information space relevant to a certain management task.

To value dimensions, ratios or measures have been introduced. Ratios are combined to ratio systems, which order ratios hierarchically and enable the top down analysis of reference objects and, thus, of business situations. Ratio systems and dimension scope combinations are assembled to information objects. An information object is a set of facts. A fact results from the combination of a ratio with a (combined) reference object, which consists of one ore more dimension objects. Information objects represent the information need related to a certain management task. Figure 4 depicts an exemplary information object containing the constructs mentioned above.

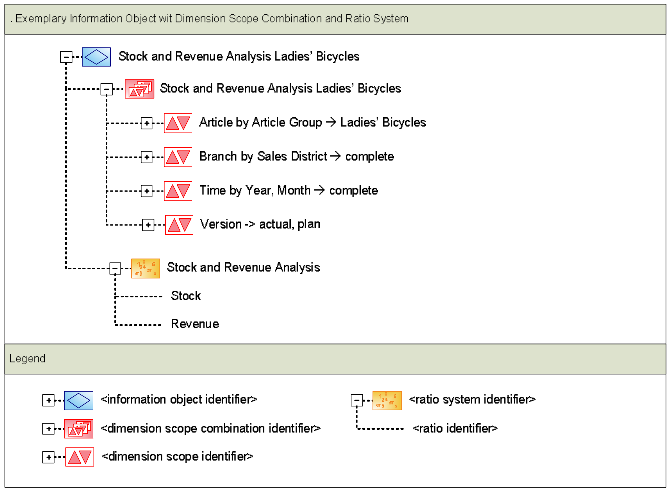

Figure 4. Exemplary Information Object wit Dimension Scope Combination and Ratio System.

Case Study: Swiss Re

The Swiss Reinsurance Company (Swiss Re) was founded in 1863. When the case study was conducted in 2002 the company had over 70 offices worldwide and employed more than 9,000 people. The company offers a wide range of products to manage capital and risk. In this case study the MetaMIS approach was used to optimize the communication between business and IT since the specification of management reports was based on documents handed over from business to IT (Holten, Dreiling and Schmid 2002). Thus, there was no tool support or language that could be used for communication between IT and business. At the outset, dimensions were constructed. These were mandatory dimensions such as time and valuation as well as company specific dimensions like *type of business*, *type of agreement*, and *type of transaction* (Holten, Dreiling and Schmid 2002). Second, dimension scope combinations were defined based on the identified dimensions. In a next step, ratio systems were identified and modeled. Here, both *basic* ratios and *calculated* ratios were accounted for. In a last step the required information objects were created to depict certain reports.

Method Evaluation and Refinement

It was found that to depict reports in Swiss Re, different facts (e. g. the combination of ratios with combined reference objects, i. e. certain facts) had to be used within calculations. This led to the introduction of a new construct called *fact calculation* (Holten and Dreiling 2002). Another finding was that there is need for the possibility of parameterization of dimension scopes (e. g. with a certain year for a dimension scope based on the dimension time) and dimension scope combinations. Furthermore, it became clear that it is useful to strictly distinguish between overall master data and report master data. Overall master data are dimensions and ratios, e. g. report master data are dimension scopes, dimension scope combinations, fact calculation and ratio systems. Overall master data are necessary to overcome misunderstandings related to homonymous and synonymous usage of terms, for example. Hence, their identification focuses on the communication gap mentioned above. Furthermore, they build the foundation for the creation of report master data and, thus, for specifying certain information needs.

Table 4 shows a scope of the changes made within this case study.

Modeling Language Construct	Decision	Reason
Fact Calculation/ Fact Calculation Expression	Introduction of a new meta model element.	There was no construct that allowed for the combination of ratios related to different combined reference objects.

Table 4. Method Rationale for Case Study Swiss Re.

Figure 5 shows an exemplary Fact Calculation from Swiss Re. It can be seen, how parameterized dimension scopes are to be used. A fact calculation consists of the relevant dimension scope combination (dimension scopes respectively), ratio system, and a fact calculation expression. If ratio systems are omitted, the fact calculation can be applied to the ratio system that is part of the information object the fact calculation belongs to.

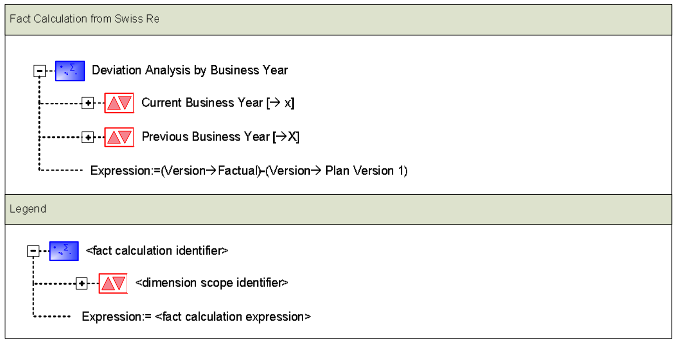

Figure 5. Fact Calculation from Swiss Re.

Case Study: Christ Juweliere und Uhrmacher seit 1863 GmbH

Christ Juweliere und Uhrmacher seit 1863 GmbH is a German retail company in the fields of jewellery and watches. The company has more than 200 branches in Germany. In the course of the introduction of a new enterprise resource planning system a new management information system was introduced as well.

In this case study both, an as-is analysis and a to-be conception, were accomplished. Within the as-is analysis eight interviews with the top management and with report receivers form different departments (sales, logistics, purchasing) were conducted (i. e. including controlling a total of 21 interviews). These aimed at identifying the actual information need. As-is models served as a communication basis between the groups mentioned and IT analysts. Besides, there was a continuous communication with the company's controlling and IT department. We had access to all report definitions and outputs. More than 150 reports were identified and analyzed. Based on the analysis of the as-is models, redundancies and deficiencies (such as synonymous terms for ratios) of the current system could be identified and suggestions for improvement were made. To-be models were derived from the as-is models and served as templates for the implementation of the future system. Moreover, these models are used for a continuous maintenance of a report repository.

Method Analysis and Refinement

It turned out that the specification of information objects was not precise enough to actually depict the company's management information system. Hence, the linking of dimension scope combinations with ratio systems was insufficient to describe reports and a more detailed description was demanded. It was found necessary to precisely define certain ratios in a report. Therefore, it was decided that dimension scopes should be linked directly to the corresponding ratios.

The intermediate results of this project led to an adaptation of the original language which entailed the possibility of completely omitting dimension scope combinations. Dimension scope combinations act solely as containers and provide the specification of a multidimensional analysis view. On a report level they do not provide any enhancements in contrast to the immediate association of dimension scopes to ratios especially when only single dimension scopes are assigned to ratios. As a result, the CMM was found to be more clearly laid out and easy to use.

Table 5 shows a scope of the changes made within this case study.

Modeling Language Construct	Decision	Reason
Dimension Scope Combination	Modification: Model element can be omitted. Thus, direct relationships between information objects and dimension scopes are allowed.	For report modeling dimension scope combinations do not provide enhancements in contrast to immediate association of dimension scopes to ratios.
Ratio	Modification: Relationships between ratios and dimension scopes are allowed.	Demand for a more detailed description of reports.

Table 5. Method Rationale for Case Study Christ.

Figure 6 shows an exemplary report specification from the as-is analysis. It can be seen that the ratio *Sales* occurs twice: Once related to the current year, once related to the last year.

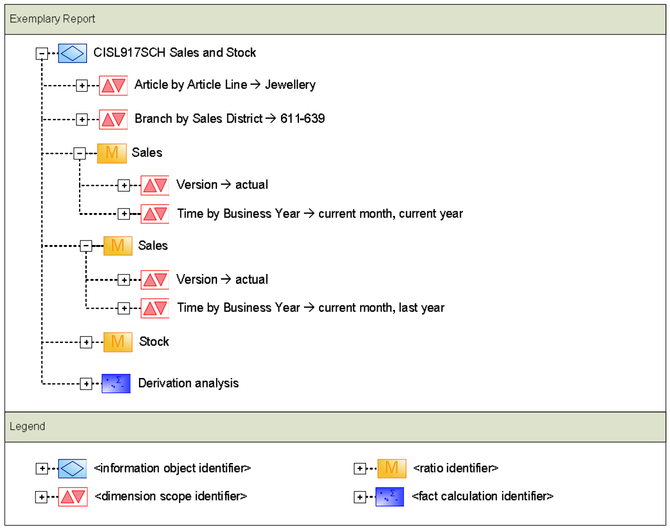

Figure 6. Exemplary Report.

Altogether, it was found that the used CMM led to a precise and comprehensive understanding of the existing management information system. During the as-is analysis deficiencies and redundancies could be identified. Furthermore, it could be ensured that no information that was already accounted for in the existing system and that would be demanded in the future system would be omitted unintentionally. As-is models served as a starting point for the to-be conception. Within the implementation phase the models were found to be useful templates that facilitated the construction of a more user adequate and redundancy free system.

4.4 Conclusion: Cross Case Analysis

Based on the performed case studies a cross case analysis was conducted. Particularly, it was found that there is need for a more detailed specification of reports. Consequently, the conceptual language and, thus, the CMM have been altered another time. A new modeling language construct was introduced and called *report*. Report specifications can be seen as starting points for the navigation within information objects. This language construct allows for a better communication with report receivers and serves as a detailed template for implementation.

Table 6 shows a scope of the changes made within this iteration step.

Modeling Language Construct	**Decision**	**Reason**
Report	Introduction of a modeling language construct	Need for representing reports for a report inventory as well as for technical implementation.
Filter	Introduction of a modeling language construct	Filters are a part of reports.
Report Row	Introduction of a modeling language construct	Report rows are a part of reports.
Report Column	Introduction of a modeling language construct	Report columns are a part of reports.

Table 6. Scope of the Method Rationale for the Cross Case Analysis.

Figure 7 shows an exemplary report specification. The columns are headlined with two ratios: stock and revenue. In the lines articles are listed by article groups. The filter allows limiting the scope on certain article groups respectively articles.

Besides the before mentioned changes in the CMM, there were others which did not affect the meta model. For example, a grammar for fact calculation expressions and naming conventions were introduced. This is due to the fact that it turned out that only a strict set of guidelines on how to create models leads to a good mutual understanding between IT analysts and system users.

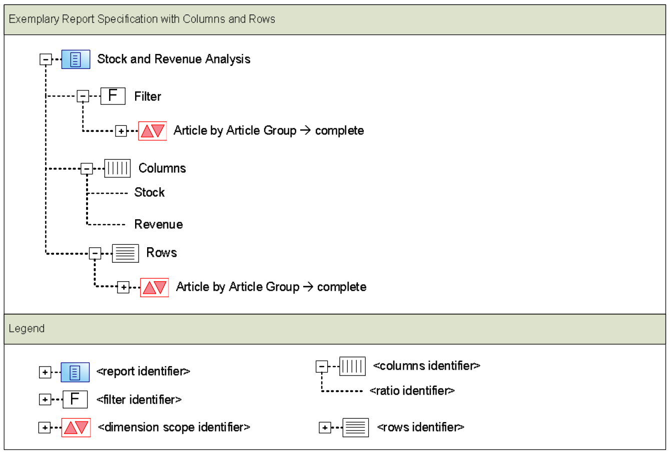

Figure 7. Exemplary Report Specification with Columns and Rows.

SUMMARY AND OUTLOOK

The basic assumption of this research was that there is a practical need for the conceptual specification of management information systems. This goal-oriented research process was accompanied by different case studies in which the CMM was evaluated. Findings of the case studies were incorporated and the CMM has continually been altered. Thus, the process of method construction was iterative. This allowed for reacting to certain demands that were project or even company specific and led to a CMM quite different to the original one.

The resulting CMM exhibits the following properties:

1. *The CMM comprises a conceptual language which can serve as a communication basis between IT developers and the management respectively the report receivers.* In the case studies it was found that the modeling language of the CMM is easy to understand and to apply by management and IT department as well. It has been observed that the models of the CMM could provide a common communication basis and hence allow for the identification and elimination of weaknesses in the management information system (H1).
2. *The models of the CMM can serve as templates to derive actual data warehouse and OLAP structures.* Since, the language of the CMM shows significant similarities with the logical languages of data warehouse and OLAP systems it is straight forward to apply the models of the CMM as an implementation template. From the case studies it could be concluded that the CMM can therefore assist the technical implementation of a management information system (H2).

Regarding to the research method introduced in this paper, the process of method construction does not end here. The experiences made in the case studies rather support the hypotheses that method engineering is an evolutionary process that continually leads to new method versions (H3). This is not only due to the fact that the CMM has not reached a state of maturity yet where changes in the CMM are only caused by variation in the environment but also due to project and company specific differences which are too singular to include them in the CMM. Therefore, we believe that the further development of the CMM will not converge to a permanently stable version of the CMM.

Besides the already mentioned practical benefits of supporting the communication between different parties involved in the reporting process and deriving data warehouse respectively OLAP structures the CMM provides an important contribution to the IS knowledge base. The CMM is an empirically proven artifact that can guide further research on management information systems. Based on the CMM and its models, theories on the efficiency and complexity of management information systems can be developed. Likewise, relations between the structure of the management information system and the success of management decisions can be identified. Hence, the conceptual representation of the management information systems of an organization enables its qualitative analysis.

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